

UNION PACIFIC RAILROAD.

REPORT OF SAMUEL B. REED,

OF SURVEYS AND EXPLORATIONS FROM

Green River to Great Salt Lake City.

JOLIET, Illinois, Dec. 24, 1864.

SIR,—According to instructions, dated March 7th, 1864, I have the pleasure of submitting the following report of my explorations and surveys in the mountains east of and in the vicinity of Great Salt Lake City:

On reporting in Omaha, Nebraska, the 2d day of April last, I found that arrangements were not made for me to leave immediately for Great Salt Lake City.

While in Omaha, information was received that the 1st Assistant assigned to my party declined the appointment—Mr. A. J. Mathewson was transferred to fill the vacancy.

Arrangements for our journey being completed, we left Omaha, April 30th, *via* Western Stage Company's line, for Atchison, Kansas, where we were delayed until the 7th of May, before we could secure our seats in the Overland stage for Great Salt Lake City.

I was informed that Governor Brigham Young would furnish all my men teams and supplies for the survey.

When I arrived in Great Salt Lake City, he was absent on a tour to Bear Lake Valley, in the northern part of the territory.

His absence caused a few days delay, however arrangements were soon made, and we commenced field work the first day of June last.

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ALT LAKE CITY TO THE MOUTH OF WEBER CANON.

point of commencement is in the northwest part of the Jordan River, which is connected by courses and divides the monument at the southeast corner of Temple Square, north latitude $40^{\circ} 45' 44''$, west longitude $112^{\circ} 06' 08''$. The altitude of the beginning of the line, as shown on the profile is $4,285 \frac{5}{8}$ feet above the sea.

From the point of commencement the line runs near the base of the mountains, in a northerly direction, past Warm and Hot Springs, and in the vicinity of the Great Salt Lake, to the mouth of Weber Cañon, a distance of $36\frac{1}{2}$ miles.

By referring to the map and profile, you will observe, that five or six miles of this distance can be saved by making a short tunnel through the low hills near the base of the mountains.

Careful surveys and estimates will determine between the line run, and the one suggested. The amount of excavation and bridging on this portion of the line is light, grades easy, and alignment good.

The altitude at the mouth of the Weber Cañon is 4,655.5 above the sea.

WEBER CANON.

On arriving at the mouth of this cañon we found it to be very narrow. The general course is direct. The sides of the cañon slope back at an angle which will admit of the road bed being made on the slope when necessary.

The river at the mouth of the cañon is 120 feet wide, and from four to six feet deep, being swollen at the time of the survey by melting of snow on the mountains. It has a strong, powerful current over a bed of water worn stones, and fallen rocks of immense size.

There is one obstacle to be overcome in this narrow gorge, known as the Devil's Gate.

A heavy point projects from the south into the valley. This deflects the river 600 feet north of its general direction. The water rushes around this bend with tremendous force, where it

is impossible to build the road on account of the short crooks, and the rapid fall in the river.

To overcome this obstruction $1\frac{1}{2}$ miles of maximum grade (116 feet per mile) will be required.

The line below the *Gate* winds along the side of the cañon, crossing ravines and projecting points of rock. From the *Gate* to the head of the gorge no heavy work is encountered.

The excavation through the cañon will be loose or solid rock. Granite and gneiss predominate.

At the upper end of the gorge $40\frac{1}{2}$ miles from Great Salt Lake City, the mountains recede to the right and left, leaving a valley from one-half to three miles wide, and $15\frac{1}{2}$ miles in length.

Here the grading and bridging will not be expensive. Easy grades and curves of long radius are obtained.

There is rock for masonry at convenient distances on either side of the valley.

A limited supply of timber can be obtained in the cañons for cross ties and bridge purposes.

The place from which a supply of timber for railroad purposes through the mountains can be procured, will hereafter be described.

From the upper end of this valley the mountains close in upon the river, forming a narrow crooked cañon six miles long. The river winds from side to side of the narrow gorge, making frequent crossings necessary. The excavation and bridging will be expensive. About one-half the excavation will be rock. Black limestone, carboniferous sandrock, and clay slate are the prevailing rocks.

Two short tunnels will be required, one at station 1,043, three hundred feet long, and one at station 1,085, four hundred feet long.

The high point crossed by the line at station 1,053 to 1,072, can be avoided on the located line. (See map and profile.)

In this cañon there is one mile t'at is very narrow.

The "debris," on both sides of the river, slopes to the water's edge. During storms of rain, or sudden melting of snow, great quantities of loose rock slide down the side of the mountain into the river.

Expensive retaining walls will be necessary to protect the road-bed.

From this place to the mouth of Echo Cañon ($5\frac{1}{2}$ miles) the valley is wide and of a very uniform surface. Excavation and bridging not expensive. Stone, for what few bridges are required, can be obtained at convenient distances on both sides of the river.

Mineral coal was seen in place, in the Weber Valley, two miles below the mouth of Echo Creek.

The dip of the rock indicates that if coal is found north of this place it will be below the bed of Weber River.

Numerous indications of iron ore were seen. The farmers living in the Weber Valley informed me that there are large deposits of this mineral on one of the small tributaries of the Weber, on the north side of the river.

The altitude of Weber Valley, at the mouth of Echo Cañon, is 5,535 above the sea.

The average grade from the Devil's Gate, $29\frac{1}{2}$ miles, is $22\frac{2}{3}\%$ feet per mile. The grade is somewhat undulating, but generally very uniform, as a reference to the profile will show.

From the mouth of Weber Cañon to this place there will be sixteen bridges over Weber River. Some tributary streams and numerous irrigating ditches will have to be crossed.

I will here remark, that the profile of the line from Great Salt Lake City through the Wahsatch Mountains *via* Weber Valley to this place, $78\frac{3}{4}$ miles, is much more favorable than I expected to find.

From the mouth of Echo Cañon to the east branch of Sulphur Creek two lines were run—one *via* Echo Creek, crossing the divide between Weber and Bear Rivers, at the head of Echo; thence down a tributary of Bear River to the same, up Bear River to the mouth of Sulphur Creek, and up Sulphur to the east branch of the same stream. This line will hereafter be more fully described.

The other line continues up the valley of Weber River, $6\frac{1}{4}$ miles, without encountering any heavy work to the mouth of

CHALK, OR WHITE CLAY CREEK.

From information received from various sources before leaving Omaha, and after arriving in Utah, I was led to believe that this

valley would prove to be the most favorable, if not the only practical route over the high divide between Weber and Bear Rivers. It was, therefore, with great anxiety that we worked our way up the valley of this stream to the summit.

The first two miles up Chalk Creek Valley is through well cultivated farms. Then the valley narrows to a cañon one mile in length, only wide enough for the bed of the stream and quite crooked. The rocky points from opposite sides of the creek projecting past each other will cause heavy rock excavation. From here the valley opens, and for a distance of $18\frac{1}{3}$ miles the excavation and embankment will be comparatively light.

The average ascending grade from the mouth of the creek to this place is $64\frac{2}{3}$ feet per mile, almost three times as much as the average in the Weber Valley above the Devil's Gate.

The approach to the summit is made with $5\frac{3}{4}$ miles of maximum grade. The excavation and embankment will be expensive. At the summit a tunnel, 2,700 feet in length, will be required, through carboniferous sand rock, with expensive approaches at each end.

The altitude is 7,834 feet above the sea. This is the highest point reached on the survey.

In the mountains, to the south, there is a large tract of pine timber, suitable for railroad purposes, accessible from this point.

From the summit to Bear River the country is very much cut up by the various small tributaries of Yellow Creek. It is necessary to cross the drainage with the line. This makes heavy work, as will be seen on the profile.

While exploring the country at the head of Chalk Creek, I became satisfied that it was impossible to cross the divide between Weber and Bear Rivers, south of Chalk Creek, on account of the near approach to the Uinta Mountains. Subsequent explorations fully confirmed this opinion.

From Bear River, which is 150 feet wide and one foot deep at low water, to the east branch of Sulphur Creek, $11\frac{1}{4}$ miles, the grading and bridging is light, alignment good, and timber convenient.

As two lines were run to this place, I will return and describe some of the distinguishing features of the

ECHO CANON LINE.

Echo Cañon is a deep gorge worn in the soft sand rock, 100 to 1,000 feet wide, and $23\frac{1}{2}$ miles long. Bold escarpments rise almost vertical from five to eight hundred feet high, and extend on the north side from Weber Valley twenty miles up the cañon, or nearly to *Cache Cave*—on the south side the hills recede at an angle of 45° .

From Cache Cave to the summit the hills are more rounded, and slope back at a greater angle, numerous short tributaries come in on both sides, cutting the country into a succession of deep ravines and sharp ridges.

From the point where we leave the Weber Valley Line, up the cañon to Cache Cave, $21\frac{1}{2}$ miles; the work is light, material good, and grades not as objectionable as in Chalk Creek Valley.

The alignment is much better than the same distance up the valley of Chalk Creek.

The summit is reached with 3.22 miles of maximum grade, where a tunnel will have to be made 4,000 feet through soft sand rock.

The altitude of this summit is 6,879 feet above the sea. The average ascent per mile from the mouth of the cañon to the foot of the maximum grade, near Cache Cave, 21.00 miles, is 44.00 feet.

From the summit, the line was run down the valley of a small tributary of Bear River, to the same; thence up Bear River Valley and the valley of Sulphur Creek to its connection with the Chalk Creek line, 24.45 miles or 49.20 miles from the mouth of Echo Cañon. The work on this last part of the line will be light. Rock for masonry convenient, and the alignment good.

By referring to the map and profile the relative merits of these two lines will be apparent.

The altitude of the summit on Echo Cañon line is 955 feet below the summit on Chalk Creek line.

The total ascending and descending grades, 1,020 feet in favor of Echo line. The alignment, excavation, and embankment is also largely in favor of this line.

Coal was seen on the Echo line in Bear River Valley, which it is believed will prove good for locomotive fuel.

The advantages of the Chalk Creek line are its proximity to large bodies of timber; its convenience to coal mines that are being worked in Chalk Creek Valley, and the difference in the length of the tunnels at the summit, which is 1,300 feet in favor of Chalk Creek line.

EAST BRANCH OF SULPHUR CREEK TO GREEN RIVER.

From this place to the summit, between the waters of the Great Salt Lake Basin and the Gulf of California, the line follows up a small tributary of Sulphur Creek two miles; thence over a low divide into the Valley of Quakingasp Creek—an affluent of Bear River,—and up that to its source on the divide, 124.87 miles from Great Salt Lake City.

From the summit we reach the Valley of the Muddy, an affluent of Black's Fork, in 7.⁷⁰ miles; 2.^{.4} miles of this is maximum grade. The altitude of the summit is 7,570 feet above tide.

The line was run down the Valley of the Muddy nearly to its junction with Black's Fork; thence 21 miles down the Valley of Black's Fork; thence over the divide, between Black's Fork and Green River, to that stream, which is 200.^{.32} miles from Great Salt Lake City. From the rim of the Great Salt Lake Basin to Green river the work is generally light, and the material good. Very little rock excavation will be encountered on this portion of the line.

Immediately after crossing the summit there is a marked change in the topography of the country. Instead of the disturbed and upheaved rocks which characterize the region of the Great Salt Lake Basin; flat tables or terraces of horizontal strata now form the distinguishing feature of the country; sometimes standing alone, like islands, in the barren plains, or forming bold escarpments along the streams. The hills are fast wearing away under the influences of wind and rain.

In Green River Valley I made thorough exploration to the mouth of Bitter Creek, a distance of twenty miles. The valley is narrow, with bold escarpments on both sides of the river, rising in many places hundreds of feet, almost vertical from the water's edge.

To follow down the valley of Green River to Bitter Creek will require sixteen bridges over the river; otherwise the work would be light.

This involved an expense which I was anxious to avoid, if possible.

The only way that seemed practicable, was to cross the high table land between Green River and the north branch of Bitter Creek.

I traversed this country, but not as thoroughly as I wanted to do, on account of the hostility of the Indians, who were committing depredations on the whites in that vicinity while we were there. I recommend that a more thorough exploration be made from Green River to Bitter Creek before a final location is made.

From Green River to the north branch of Bitter Creek the grading will be expensive. Some rock excavation will be encountered, as shown on the profile.

This is over a desert country. No fresh water was found, and but very little grass for our animals.

From the place where we descend to the valley of the North Branch of Bitter Creek to Rock Springs, the point of connection with Mr. Evans' line, the grading and bridging is light.

It will be seen by an examination of the profile that to follow this line over the high table land the altitude to be overcome is very much increased.

From Great Salt Lake City, *via*. Echo Canon line, to our connection with Mr. Evans' line in Bitter Creek Valley, is 233.⁴⁶ miles. The altitude at that point is 6,315 feet above the sea.

It will be observed that the profile shows a great preponderance of light work; there is a portion that is very heavy, but I think the work will compare favorably with the Baltimore and Ohio or Pennsylvania Central Railroads.

TIMPANOGOS VALLEY LINE.

This second line through the Wasatch Mountains was commenced at a point in the Weber Valley line, near the mouth of Chalk Creek, and continued up the valley of Weber River, to and across Kamas Prairie, 26.³⁴ miles, to the Timpanogos Val-

ley. The work over this portion of the line will be very light, grades easy, and alignment good. Stone, for all the bridge structures required, convenient and abundant.

In order to conform as near as practicable to instructions, I made an extended reconnaissance of the valley of Weber River to its source, to satisfy myself beyond a doubt about the practicability of a line crossing the divide between Weber and Bear Rivers south of Chalk Creek.

My route was up the narrow valley of Weber River, in a northeasterly direction, 20 miles from Kamas Prairie, where the river is doubled back upon itself, and heads five miles east of Kamas Prairie. The high mountain range which forms the divide, is from 1,800 feet in the lowest pass, to 4,000 feet above Weber River. The summit appears to be not more than two miles from the river and is like a continuous solid wall. The water-shed to the river is narrow and steep. The altitude of the lowest point on this divide is 9,162 feet above tide. I crossed over the divide to the west branch of Bear River, and followed up that stream in a southwesterly direction, fifteen miles, to its source. From a high point, the sides of which were covered with snow, I could trace the valleys of the various rivers that take their rise in the Uinta Mountains. On my return, I followed the crest of this divide a distance of twenty miles, to the place where I crossed it on my outward trip.

I am satisfied there is no possibility of getting a line over this divide without a tunnel at least three miles long, and at a much greater altitude than on the Chalk Creek line.

In the mountains I saw an abundance of white and Norway pine timber, suitable for railroad purposes. That growing on the Bear River slope is of easy access, and can be rafted down the river to the line.

On my return, we continued the line down the valley of Timpanogos River to the valley of Utah Lake.

Heavy work and $2\frac{2}{5}$ miles of maximum grade is encountered to get from Kamas Prairie down to the valley of the river. From thence, down the valley of the stream, $8\frac{6}{5}$ miles, the valley is narrow, and the grading and bridging will be expensive. From thence across Round Prairie, $11\frac{3}{5}$ miles, good grades, easy curves, and light work, are obtained.

From the west end of Round Prairie to the mouth of the cañon in Utah Lake Valley, $11\frac{2}{3}$ miles, the most difficult part of this line is encountered. The cañon is narrow, and, unlike Weber, is very crooked. The points, from opposite sides of the river, project past each other, making frequent crossings of the river necessary, and a constant succession of heavy rock excavations unavoidable.

The prevailing rocks are granite, lime and sand. No indications of coal were seen in this valley.

Thirty-four bridges will be required across the Timpanogos River.

The grade from the mouth of the cañon, to the foot of the maximum grade near Kamas Prairie, $31\frac{4}{7}$ miles, averages 47 feet per mile.

From the point where the Timpanogos River enters Utah Lake Valley, there is a wide table land or terrace extending from the mountains to the lake. We ascended from the Timpanogos Valley to this terrace, and ran in a northwesterly direction through the thriving towns of Battle Creek, American Fork, and Lehi; crossed the *Jordan River* at the narrows; from thence over the extensive stock range on the west side of *Jordan* to the point of the *West Mountain*, which is 12 miles west of Great Salt Lake City. From thence westerly between the base of the *West Mountains*, and the Great Salt Lake to the end of our line in Tuilla Valley, $106\frac{2}{3}$ miles from the Weber Valley line, near the mouth of Chalk Creek.

An examination of the profile will show the work in Utah Lake Valley, and the valley of Great Salt Lake, with the exception of crossing the *Jordan River*, to be light. The grades and alignment are unobjectionable.

EXPLORATIONS.

During the summer, and after the above surveys were completed, I made extensive explorations of the Wahsatch, Uinta and Bear River Mountains.

The Wahsatch range was crossed at every place where there seemed to be a possibility of finding a line through the mountains between Timpanogos and Weber Rivers.

Between Weber and Bear rivers I traversed the summit of the mountains from the head waters of the Timpanogos River, in the Uintas, north to the source of Lost Creek (known on Stanbury's map as Pumbar Creek.) Echo Cañon Line crosses this divide in the lowest place on the range.

Between Bear River and Muddy, I followed the rim of the Great Salt Lake Basin, from the head of Sulphur Creek, in the Uinta Mountains, to the head waters of Ham's Fork, crossing with my line at the lowest place on this summit, which divides the waters of Great Salt Lake Basin from those of the Gulf of California.

From these explorations I am satisfied that I have shown the best line that can be found through the Wahsatch range, north of the Uintas, unless a line should be run down the valley of Bear River. This, if practicable, will increase the distance to Salt Lake Valley about 80 miles.

You will observe that I have confined myself to the maximum grade. When I could not overcome the various difficult summits that I encountered, I abandoned the survey and sought a new line.

TIMBER AND FUEL.

This is an important subject, and it was with great interest that I observed the various places from which a partial supply of timber can be obtained. Before exploring the Uinta Mountains, I looked upon the scarcity of timber as the most serious obstacle to be overcome in building the road through the mountains.

On the head waters of Bear River, contiguous to the various tributaries of that stream, there are large tracts of white and Norway pine, suitable for railroad purposes, that can be rafted down Bear River to the line.

I was informed by Mr. Granger, who lives on Ham's Fork, that there is a large tract of pine timber on Green River, 40 miles north of the crossing of that stream. If this information is correct, of which I have no doubt, cross-ties can be obtained from there, and rafted down Green River to the line, to build the road between Green and Bear Rivers.

In the Wahsatch Mountains a limited number of cross-ties and some bridge timber can be obtained.

Coal is abundant on Bitter Creek, Ham's Fork, Sulphur Creek, Chalk Creek, Weber and Bear Rivers.

Indications of coal were seen on the Muddy, Yellow Creek, and in Echo Cañon.

There are Petroleum springs in the valley of Sulphur Creek, and in Pioneer Cañon, about three miles north of the place where the line crosses the divide between Bear River and Muddy.

We closed our work and started for Omaha on the 28th day of October. We encountered severe storms in the mountains and on the plains, which prevented our reaching Omaha until the 18th day of November.

In conclusion, I wish to acknowledge my obligation to Governor Brigham Young for the courteous and gentlemanly treatment I received from him. To his cheerful and prompt compliance with all my requisitions for men, means of transportation, and subsistence, the company are in a great measure indebted for my success.

To Mr. Granger, for supplies loaned us, and for his valuable assistance in exploring the country in the vicinity of Black's Fork and Green River without charge.

To Mr. A. J. Mathewson, F. J. Paris, J. F. Smith, assistants, and all other members of the party I am obliged for valuable assistance rendered during the survey.

All of which is respectfully submitted,

SAMUEL B. REED,
Division Engineer.

To T. C. DURANT, Esq.,
Vice-Pres't U. P. R. R. Co.,
No. 13 William st., New York.

TABLE OF ALTITUDES.

	Feet above the sea.
The end of the line in Great Salt Lake City.....	4285.8
" mouth of Weber Cañon.....	4654.7
" Devil's Gate, in Weber Cañon.....	4894.0
" Weber Valley, at the mouth of Echo Cañon.....	5535.0
" " " " Chalk Creek.....	5645.0
" summit at the head of Chalk Creek.....	7834.0
" summit at the head of Echo Cañon	6879.4
" surface of water in Bear River, on Chalk Creek line.	7503.0
" " " " Echo Cañon line.	7045.0
" summit between Bear River and Muddy, the rim of Great Salt Lake Basin.....	7567.0
In the valley of Muddy, near the Overland Stage Station.	7067.0
The surface of water in Black's Fork, two miles below the mouth of Muddy.....	6375.0
" surface of water in Black's Fork, twenty miles below the above.....	6257.0
" summit between Black's Fork and Green River.....	6464.0
" surface of water in Green River.....	6245.0
" summit between Green River and north branch of Bitter Creek.....	7175.0
" Bitter Creek Valley, at the junction of Mr. Evan's line.....	6315.0

TIMPANOGOS LINE.

The end of the line in Tuilla Valley.....	4243.0
At the point of the West Mountain.....	4267.0
The surface of water in the Jordan River, at the Narrows.	4522.0
In the Timpanogos Valley, at the mouth of the Cañon..	4892.0
In the Timpanogos Valley, at Kamas Prairie....	6391.0
On Kamas Prairie.....	6667.0
The surface of water in Weber River, at the north end of Kamas Prairie.....	6340.0
The mouth of Chalk Creek, in Weber Valley.....	5645.0

The principal bridges on the line, from Great Salt Lake City to Bitter Creek, *via* Echo Cañon line, are—

	Lineal feet.
16 Truss bridges over Weber River, of 250 feet each....	4,000
5 " " small stream in Weber Valley of 100 ft. each.....	500
30 Bridges over Echo Creek, 40 feet each.....	1,200
6 " " Yellow Creek and branches, 40 ft. each..	240
Truss bridge over Bear River	600
30 Bridges over Muddy.....	60 ft. each.. 1,800
3 Truss bridges over Black's Fork.....	300 " .. 900
1 " " " Green River.....	800
10 Bridges between Green River and Bitter Creek.....	400
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	10,400

TIMPANOGOS LINE.

	Lineal feet.
1 Truss bridge over Jordan River.....	300
1 " " " American Fork.....	150
1 Bridge over Battle Creek.....	50
34 Truss bridges over Timpanogos, 300 feet each.....	10,200
3 " " " Weber River, 250 feet each.....	750
3 Bridges over Beaver Creek, 40 feet each.....	120
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	11,570

In addition to the above, there will be numerous irrigating ditches and small streams to cross.

TABLE OF GRADES.

Level.		0 to 20 Ft. per Mile.		20 to 40 Ft. per Mile.		40 to 60 Ft. per Mile.		60 to 80 Ft. per Mile.		80 to 100 Ft. per Mile.		100 to 116 Ft. per Mile.	
Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
From Great Salt Lake City, via Weber Canyon & Chalk Creek to Bitter Creek....	25.84	24.21	295.3	332.5	32.27	917.2	23.31	658.4	16.99	571.1	19.71	722.6	16.82
	25.90	24.77	356.4	31.50	425.5	40.17	1202.6	24.17	630.4	20.57	1072.0	11.15	592.4
From Tullia Valley, via West Mountain River, Jacobs, Timpanogos Valley and Kamas Prairie to Weiser Valley near mouth of Chalk Creek	9.39	4.53	88.0	8.43	124.0	12.97	382.0	12.06	345.0	18.00	702.0	11.57	618.0

